L4S Architecture: Low Latency, Low Loss, Scalable Throughput Internet Service
draft-ietf-tsvwg-l4s-arch-00
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The authors were part-funded by the European Community under its Seventh Framework Programme through the Reducing Internet Transport Latency (RITE) project (ICT-317700). The views expressed here are solely those of the authors.
Recap

- **Motivation**
  - Extremely low queuing delay for all Internet traffic

- **Architecture**

  ![Diagram](attachment:image.png)

  - $r \propto 1/p$
  - $r \propto 1/\sqrt{p}$

  - $r$: packet rate
  - $p$: drop/mark probability
tsvwg-l4s-arch status

• Adopted. Now in a holding pattern
  • pending possible changes to main assumptions about the “TCP Prague Requirements”
  • Reviews, comments from implementers etc, obviously welcome
  • Same applies to tsvwg-ecn-l4s-id and tsvwg-aqm-dualq-coupled

• Two types of TCP Prague requirements:
  • Safety
  • Performance Improvements
    (e.g. rapid dynamics – presented yesterday in ICCRG)

• Come out of holding pattern when safety reqs met
  • Q-delay already 1-2 orders of magnitude better than state of the art
  • 500 μs vs 5-15 ms (FQ-CoDel or PIE)
L4S Status Update (TBA)

• Source Code
  – Dual Queue Coupled AQM, DualPI2 for Linux [UPDATED internally, release shortly]
  – Data Centre TCP (DCTCP) for Linux (in the mainline kernel), FreeBSD patch, ns2 patch.
  – Accurate ECN TCP Feedback for Linux [UPDATED, but still not fully tested]

• IETF specs
  – Low Latency, Low Loss, Scalable Throughput (L4S) Internet Service: Architecture <draft-briscoe-tsvwg-l4s-arch>
    [Adopted by IETF tsvwg]
  – A proposed new identifier for Low Latency, Low Loss, Scalable throughput (L4S) packets <draft-briscoe-tsvwg-ecn-l4s-id>
    [Adopted by IETF tsvwg]
  – enabled by <draft-ietf-tsvwg-ecn-experimentation> [Completed WGLC]
  – Dual-queue AQM: <draft-ietf-tsvwg-aqm-dualq-coupled> [UPDATED with overload pseudocode]
  – scalable TCP algorithms, e.g. Data Centre TCP (DCTCP) <draft-ietf-tcpm-dctcp>, TCP Prague [In Progress]
  – Accurate ECN: <draft-ietf-tcpm-accurate-ecn> [UPDATED]
  – ECN++ Adding ECN to TCP control packets: <draft-ietf-tcpm-generalized-ecn> [UPDATED & Adopted]
  – ECN support in trill <draft-ietf-trill-ecn-support>, motivated by L4S [Completed WGLC]
  – ECN in QUIC <draft-johansson-quic-ecn>, motivated by L4S [UPDATED individual draft]

• 3GPP Proposal
  – ECN visibility to Radio Link Control (RLC) layer, motivated by L4S [Discussed, decision deferred to Aug'17]

• Papers
  – Article in the IETF Journal describing the Demo in Bits-N-Bites at the IETF in Prague, July 2015. “Ultra-Low Delay for All”
  – “Data Centre to the Home: Deployable Ultra-Low Queuing Delay for All” [Rejected – non-novel wrt IETF → Journal submission]
Identifying Modified ECN Semantics for Ultra-Low Queuing Delay
draft-ietf-tsvwg-ecn-l4s-id-00

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**Premium Service vs. Default?**

<table>
<thead>
<tr>
<th>Codepoint</th>
<th>ECN bits</th>
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<tbody>
<tr>
<td>Not-ECT</td>
<td>00</td>
</tr>
<tr>
<td>ECT(0)</td>
<td>10</td>
</tr>
<tr>
<td>ECT(1)</td>
<td>01</td>
</tr>
<tr>
<td>CE</td>
<td>11</td>
</tr>
</tbody>
</table>

- Classifier on 2-bit ECN field in IP header (v4 or v6)
  - if ECT(1) or CE, forward to L4S
  - adopted for standardisation by IETF
  - ECN field works end-to-end
    - network could solely enable L4S for certain addresses
    - later, could enable for all addresses
  - in all cases, no packet inspection deeper than IP
    - compatibility with all privacy technology

- Classifier on any other field
  - src/dst IP address
  - VLAN ID,
  - DSCP (local or global?)
  - bearer, …
Load balancers and ToS byte

- **ECN++**
  - ECN on all TCP control packets
  - draft-ietf-tcpm-generalized-ecn (tcpm on Monday)
  - all packets of one flow have consistent ECN field
  - removes need for exceptions in load balancers

- **NB: still exceptions**
  - ECT can change to CE
  - Legacy 8-bit classifier hardware still needs to change to 7 bits

<table>
<thead>
<tr>
<th>TCP packet type</th>
<th>AccECN f/b</th>
<th>RFC3168 f/b</th>
<th>Congestion response</th>
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<tr>
<td>SYN</td>
<td>ECT</td>
<td>not-ECT</td>
<td>Reduce IW</td>
</tr>
<tr>
<td>SYN-ACK</td>
<td>ECT</td>
<td>ECT</td>
<td>Reduce IW</td>
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<tr>
<td>Pure ACK</td>
<td>ECT</td>
<td>ECT</td>
<td>None or optionally AckCC [RFC5690]</td>
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<td>ECT</td>
<td>ECT</td>
<td>Usual</td>
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<tr>
<td>FIN</td>
<td>ECT</td>
<td>ECT</td>
<td>None or optionally AckCC [RFC5690]</td>
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